WASHINGTON
SCIENCE TRENDS

HIGHLIGHTS

SPECIAL SUMMARY REPORT
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RESEARCH AND DEVELOPMENT
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NATIONAL AERONAUTICS
AND
SPACE ADMINISTRATION

Vol. IV, No. 20 August 1, 1960

SPECIAL REPORT

Some 1300 contractors for the National Aeronautics and Space Administration met in Washington during the past week for classified briefings on future plans and programs. Here is a Special Report emphasizing research and development requirements and contracts planned for the months and years ahead.

* PROJECT APOLLO

Project Apollo will be the advanced manned space flight program to follow Project Mercury. During the current fiscal year contractors will be invited to participate in a program of systems studies. It is believed probable that a contract for the design, engineering and fabrication of this spacecraft system may be initiated in fiscal year 1962.

According to NASA specifications, the Apollo spacecraft must be flexible enough to be capable of both circumlunar flight and earth-orbital missions. In the long run, it is stated, this craft should lead toward manned landings on the moon and planets, and toward a permanent manned space station.

ø Modular Construction -- Key to this flexibility will be a "modular concept" in which various building blocks will be employed. These include:

√ Command Center Module -- to house the crew during launch and reentry and serve as the flight control center for the remainder of the mission. This module would probably be identical for both circumlunar and earth-orbital missions.

√ Propulsion Module -- This section would be equipped with enough propulsion to permit safe crew recovery from aborted missions. Such capability must be provided for an abort at any speed up to maximum velocity, and should be independent of the launch propulsion system. The module would also be used when needed for mid-course corrections, maneuverability, etc.

√ Mission Module -- According to tentative plans, the Apollo spacecraft would carry a three-man crew located in the command center unit during launch and reentry. For the remainder of the flight at least two of the crew would be in the mission module. Pressure suits may be acceptable but the mission module should definitely be designed to permit "shirtsleeve" operations.

ø Requirements -- The Apollo spacecraft will require many systems and subsystems. Major developments needed include: Basic reentry vehicle; perhaps several environmental control systems; attitude sensing and control system; power supplies (400 kw hours on a circumlunar mission with a peak load of roughly 4 kilowatts); voice, telemetry and possibly tv communications; onboard propulsion; guidance, control and pilot display systems. The latter should supply the pilot with sufficient information to permit him to make trajectory corrections, to enter and stay within the appropriate "corridor" and land at a preselected location.

* SPECIAL REPORT (Continued)

ø Ground Instrumentation

NASA expects to spend $10 million this fiscal year for advanced development in the area of ground instrumentation. Major emphasis will be placed on:

√ Information Theory -- More information per watt is the goal. Improvements required include communications efficiency and data-handling techniques based on application of information theory.

√ Data Reduction and Computation -- Basic research and development should be directed toward rapid and random access computer memories suitable to data reduction and orbit computation. This is to be combined with efforts to reduce data reproduction effort, such as efficient pre-editing procedures.

√ Low-noise Multipurpose Receiver Components -- "Most helpful" would be development of phase-stable, low noise, parametric or maser amplifiers for ground and space-borne applications in frequency ranges near 400, 1,400, 1,700 and 2,300 megacycles.

√ Data Communications Between Sites on Earth -- New and improved methods of reliable data transmissions are needed to effectively make use of tracking and telemetered data.

√ Large Aperture Antennas -- Receiving antenna systems having high-gain, low-noise characteristics suitable for multiple or broad-band frequency band usage would be of value.

ø Power Generation Systems

NASA expects to spend $4.7 million during this fiscal year for solar and chemical auxiliary power projects. Research will emphasize overcoming some of the present problems encountered with solar-cell power supplies. This includes:

√ Radiation Damage -- Protons and electrons in the Van Allen Radiation belts cause degradation of the power output of solar cells.

√ Reliability -- This includes the "unreliability" of storage batteries for operation in a vacuum, particularly with multiple recycling at high ambient temperatures.

√ Cost -- NASA is concerned over the high production and installation cost of solar cells, estimated to be of the order of $500,000 per electrical kilowatt.

Future Projects

√ Solar-Thermionic System -- This system would use cesium vapor thermionic converters. A program will be initiated this fiscal year to develop lightweight solar collectors of high optical accuracy which are required to supply heat to a thermionic converter at temperatures of 2,000° to 3,000°F. (NASA believes that metallic collectors may be the most reliable although foam-inflated plastic mirrors or other types may prove satisfactory. A collector weight of less than 2/10th pound per square foot is the goal.)

√ Fuel Cell System -- Solar power may prove less favorable than a chemical system because of the need to maintain sun-orientation of the solar collector. A fuel cell system, it is believed, could be much lighter than a battery or even a combustion-type system using H_2 and O_2. One or more contracts will soon be placed to prove feasibility and practicability in space missions, particularly in zero-gravity conditions where the control of phase separation between liquid water and the gaseous fuel may be troublesome.

* SPECIAL REPORT (Continued)

ø Space Instrumentation

NASA plans to spend $55 million this fiscal year on the development and manufacture of spacecraft and payloads, exclusive of launching vehicles. Of this sum, $35 million will be subcontracted to industry and universities. Requirements include:

Observational Instruments

√ Television -- ranging all the way from microscopic examinations of particles to far-scanning of the lunar terrain.

√ Radar -- to be utilized both on the surface of the moon and planets and in orbit, to determine not only position but contour of the land and perhaps some of the surface structure.

√ Spectrometers -- of all types, including the X-ray, fluorescent, gamma-ray and mass varieties.

√ Other -- Includes seismometers, magnetometers, penetrometers, chemical analyzers, microbiological equipment and gravimeters.

Environmental Instruments

√ Radiation Detectors -- of all types, covering all ranges of the energy spectrum, and "hopefully" discriminating between particle types and electromagnetic radiation.

√ Micrometeoroid Detectors

√ Gages -- for pressure, temperature and ionization

√ Sound Detectors and Analyzers

√ Mass Spectrometers

ø Satellite Application Plans

NASA plans to spend some $20.5 million this fiscal year on satellite applications, particularly in the field of meteorology and communications. A contractor will be selected early this fall for system integration and basic structure for the Nimbus series of operational weather satellites. Contracts will also be let for sensory systems, stabilization and power supply. Further in the future is Project Aeros, a concept for meteorological satellites in a 23,300 mile orbit which might be initiated in calendar year 1962. Project Rebound is the code name for a program of multiple passive satellites for communications relay, which may begin during 1963.

Requirements include:

Meteorology

√ Attitude sensors and stabilization systems

√ High-Resolution TV systems and Infrared-Sensitive TV tubes

√ Data storage and transmission systems and on-board data analysis systems

√ Period Control Systems, Power Supplies, Radar

Communications

√ Inflatable structures, plastics for space environment, passive stabilization and period control systems.

* SPECIAL REPORT (Continued)

ø Propulsion

NASA plans to spend some $6 million this fiscal year for work in the field of advanced liquid-propellant rocket technology. Research problems to be solved include:

√ Environment -- a better understanding of the nature of the space environment and its effects on propulsion equipment and propellants.

√ Lunar -- development of propulsion systems for landing and takeoff on lunar missions.

√ Auxiliary -- advanced development will include orbital and trajectory correction propulsion, as well as space vehicle rendezvous.

√ Combination -- NASA is interested in improved propellant combinations of high performance and compatibility with the space environment.

√ New Configurations -- novel engine designs which will result in higher overall vehicle performance.

√ Improved Operational Procedures, equipment, design and fabrication techniques. Of particular interest is the design of improved pump inducers to lower tank pressurization requirements.

√ Improved Instrumentation -- including flow, pressure and thrust-measuring devices to meet the particular requirements of space rocket testing.

√ Rocket Engine Development -- several areas still create problems. One is combustion-driven oscillations.

NASA plans to spend some $2.8 million this fiscal year for improved solid propellant rockets. Research problems to be solved include:

√ High-Performance Motors -- Reducing rocket inert weight is an important program, and rockets which are 96 percent propellant should be possible. Large booster design studies are in progress as possible first stages. Methods of steering, clustering and overall costs are to be studied.

√ Attitude and Velocity Control -- solid propellant rockets, it is suggested, can be more efficient and less complex if such features as attitude and velocity control can be divorced from the basic rocket design and incorporated as an auxiliary system.

√ Materials and Manufacturing -- A basic problem is development of materials capable of resisting erosion and combustion temperatures which will exceed 6000°F. Most of this program is under the Department of Defense.

√ Improved Propellants -- Some work for NASA is being carried out by the Jet Propulsion Laboratory, but most of this is also a Defense Department program.

NASA plans to spend some $3.3 million this fiscal year for work in the field of electrical propulsion. Programs include:

√ I-Kilowatt Arc-Jet -- to provide torque to control angular orientation of a spacecraft. This system might replace gas bottles and other techniques.

√ Arc-Jet Engine operating from a 30-kw nuclear electric power supply -- to develop the first electrical thrust device for experimental flight testing as a Saturn upper stage in the 1965 time period.

√ Cesium Ion Engine -- to develop engine and propellant feed-system components for a 30-kw ion rocket engine with a thrust of 1/10th pounds for a 1965 flight test.

* SPECIAL REPORT (Continued)

Electrical Propulsion Problem Areas which may lead to research contracts:

Arc-Jet Engines

√ Arc Stability

√ Materials

√ Cooling of Electrodes, nozzle, plenum chamber

√ Dynamics of chemically reacting fluids

√ Optimization of nozzle and electrode designs

√ Propellant Selection and storage

Ion Engines

√ Propellant storage, feed and vaporization, ionization, acceleration, neutralization, materials

MHD (Magnetohydrodynamic) Engine

√ Plasma physics

√ Cooling of electrodes

√ Chemical reactions involving gases and materials

√ Materials

√ Electrical conductivity of gases

√ Propellant selection, storage and feed

√ Plasma dynamics in a magnetic field

√ Design optimization of electrodes

On a long-range basis electrical thrust devices should, if possible, be developed in units that can be clustered to cover a range of total thrust values, perhaps in a series beginning with 0.01 pounds and continuing with 0.1 pounds and 1 pound units. These should be compatible with Atlas-Centaur and Saturn vehicles. For systems of 10-pound thrust and more in the 1970's, early research is needed on high-capacity ion and plasma accelerators and on electrical power units of multi-megawatt capacity.

ø Nuclear Energy Research

NASA is spending some $10 million this fiscal year on nuclear heat-transfer rockets and nuclear-electric-power generating systems. Future developments include:

Nuclear Rocket -- Engine and vehicle program is aimed at the development of a system to flight-test a nuclear rocket stage using the low-power KIWI reactor now being developed. Hardware development by industry is planned as soon as tests have been run on a reactor using liquid hydrogen as a propellant. Two studies are being initiated to define flight-test vehicle configurations and program.

Nuclear Electric Systems -- Prime project in this field is the 30-60 kilowatt SNAP-8 system being developed by industry. Applied research is also required for higher-power systems. Projects include the effect of space environment on materials; liquid-metal and vaporized metal technology; and such components as high-temperature generators and metal-vapor turbines, condenser heat-rejection systems and liquid-metal bearings and seals. Eventually, it is hoped, power-generating systems can be developed capable of delivering megawatts of power with specific weights down to approximately 10 pounds of engine per kilowatt.

* SPECIAL REPORT (Continued)

ø Space Science Experiments

NASA expects to spend some $5½ million this fiscal year for sounding rocket studies and payloads, and about $2½ million for sounding rocket vehicle procurement. During the same period, about $33 million is planned for satellite spacecraft work. Industry is invited to respond to the many needs for product development and improvement in connection with these tasks.

Sounding Rockets

NASA now uses some 11 types of sounding rockets and intends to restrict these systems to a relatively limited number. When it becomes desirable to improve performance for existing vehicles the Goddard Space Flight Center will request proposals. Whenever possible, commercially available electronic and mechanical systems will be used. Future requirements for development include sensors; gages for the measurement of pressure, temperature, magnetic field, electromagnetic and particulate radiation and other scientific instruments for upper atmosphere and near-space studies.

Earth Satellites

"Stock" spacecraft are a NASA goal in the field of scientific research. It is hoped that in successive satellites of larger sizes it will be possible to merely exchange the scientific sensors and specialized signal conditioning devices from flight to flight without affecting the fundamental satellite design. This trend will be followed, when possible, in two new systems now under development, the Orbiting Geophysical Observatory and the Orbiting Astronomical Observatory. Procurement action has already started on the latter, and in about 4 to 6 months industry will probably be asked for expressions of interest in the Geophysical satellite. At a later date NASA expects to begin procurement activity in support of satellites for use with the smaller Scout launching vehicle.

Research requirements in the satellite field include means of heat dissipation from internal devices, intermixing of scientific instruments and sometimes a number of radio frequency systems without interference, and means of assuring that equipment will operate under a power supply which may fluctuate both in connected load and energy input. Other requirements:

√ Desensitization -- making components and subsystems so stable that their variation in response to changes in pressure, temperature, vibration, acceleration and radiation becomes negligibly small. If this cannot be done active or passive techniques to control environment must be used.

√ Instruments and Subsystems -- including ion mass spectrometers, vacuum gages, radiation detectors and analyzers, directional magnetometers, plasma probes, telescope pointing controls.

This Special Report summarizes papers presented to NASA contractors at a special Washington briefing during the past week. Other briefings, more specialized in character, will be held at various NASA Research Centers during the coming months. Complete texts of papers presented in Washington will be available in the near future, except for classified portions. Watch Washington SCIENCE TRENDS for details.

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